M-Velanmai Application: Leveraging AI Based Extension Advisory System for Rice Farmers

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Keywords: *M-Velanmai*, Rice Plant Protection, Artificial Intelligence, Machine Learning.

Abstract: "*M-Velanmai*" app. is an interactive, demand driven and personalized android mobile based extension advisory system for accessing, appropriate and timely technological information / decision support in agriculture by the farmers of Tamil Nadu. The app is designed to work on android mobile phones. "*M-Velanmai*" uses the techniques of artificial intelligence and machine learning to provide two types of support services viz., decision support and information support for the benefit of farmers. The farmer will be given provision to record their response regarding the level of satisfaction upon adoption of advisories as a feedback for the extension service availed. The "*M-Velanmai*" app. developed for rice can be extended for other major crops of Tamil Nadu in near future.

1 INTRODUCTION

Climate change, pest and disease outbreaks, scarcity of water, labor crisis, rising population and a resultant rise in food demand are the challenges that agriculture sector is dealing with. To overcome these challenges farmers must be provided with diverse of precise information throughout the crop period in order to make well-informed decisions and overcome these challenges in agriculture. Apart from these constraints, global pandemic is also limiting farmer's interaction with scientists. Due to low rate of adoption of agricultural technologies by farmers there is no significant increase in crop productivity. This highlights the necessity to employ highly sophisticated technologies like AI to help farmers in enhancing the outcomes from agriculture. Artificial intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think like humans and mimic their actions (Frankenfield, 2021).

Unique advantage of applying AI in agriculture is that objective decisions are made based on quantitative assessment of data unlike the case of relative and subjective decisions made by farmers/experts based on visual examination. AI is utilized in the field of agriculture for:

1. Increasing the share of price realization to producers (Eg: Predictive analytics using AI tools to get supply and demand information to famers)
2. Soil health monitoring and restoration (Use of image recognition an DL models)
3. Crop health monitoring and providing real time action advisories to farmers (To predict advisories for sowing, pest control, input control)
4. Analyzing farm data (Analysis of weather conditions, temperature, water and soil conditions)
5. Seasonal forecasting (To create seasonal forecasting models to improve agricultural accuracy and increase productivity)
6. Precision agriculture (NITI Aayog and IBM have collaborated to develop an AI-based crop

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Chandrasekaran, K., R., S. S., S., P. and Kumar S, A.
M-Velanmai Application: Leveraging AI Based Extension Advisory System for Rice Farmers.
DOI: 10.5220/0012882900004519

In *Proceedings of the 1st International Conference on Emerging Innovations for Sustainable Agriculture (ICEISA 2024)*, pages 116-120
ISBN: 978-989-758-714-6

yield prediction model to detect diseases, pests, and poor plant nutrition)

7. Tackling the labor challenge (AI agriculture bots that augment the human labour workforce)

8. Customized and personalized assistance to farmers (AI based Chatbots to provide recommendation and advice on farmer's problems)

9. Increasing efficiency of farm mechanization (Image classification tools combined with remote and local sensed data).

M-Velanmai ('Mobile-Agriculture' in English) – is an Artificial Intelligence based bilingual extension advisory system delivered through android mobile application is conceived to extend decision support services. The app is being created using deep learning/ machine learning technologies to detect the crop damage symptoms (insects and diseases) instantly & offer reliable and cost-effective advisories in one of the major crop of Tamil Nadu i.e. Paddy. (Karthikeyan, 2020)

The app has been designed to work on android mobile phones. *M-Velanmai* uses the techniques of artificial intelligence and deep learning to provide two types of support services viz., decision support and information support mainly for the benefit of farmers in Tamil Nadu.

The app. will be user friendly which does most of the operations in single touch as it has been intended for the farmers (users) were the user is given provision to record their response regarding the level of satisfaction upon adoption of advisories as feedback for the extension service availed.

2 MATERIALS AND METHODS

In order to build an AI model using Machine Learning/ Deep Learning technologies the following five major activities need to be carried out which forms the basis for creating the framework in *M-Velanmai* application development. They are,

A. Data collection
B. Data pre-processing
C. Data Augmentation
D. Feature extraction
E. Object Detection

A. Data collection

High quality images of the crop damage symptoms with varied resolutions under diverse backgrounds were captured using Digital camera and Smartphones. The image library was built by capturing more than 80,000 pictures of damage symptoms of Paddy in real field situations under all crop growth stages and varied environmental conditions from the pest hotspots of Tamil Nadu.

The data collection forms the first step in building the pest detection model. It is well aware that, the quality of output is deeply influenced by the quality of input, high quality images were collected by DSLR and smartphones under diverse scenarios such as different resolutions, under different crop growth stages in different times of the day i.e., morning, afternoon and evening hours in order to better represent realistic working conditions in various environmental and illumination conditions. Various studies have reported that the AI models developed with inputs obtained from controlled conditions fail to make accurate predictions in real field situations. Taking this into consideration, we captured the images in real field settings with and without background under different lighting conditions to improve the reliability of the performance of the model.

B. Data Pre-Processing

Data pre-processing involves manual labeling and cropping the images to give major focus on the region with symptoms in the photos captured. To work with Convolutional Neural Network (CNN) models, large datasets with manually labeled targets are required. Initially when it was started to train the model to classify the infected images from the healthy ones, it has been the issues of misclassifications with a dip in the prediction accuracy was confronted. Then it has been tried with cropped images where we could observe an improvement in the model performance metrics. Hence, data pre-processing work serves as the mandatory prerequisite for preparing the data for training the machine. Here, the symptoms were labeled used LabelImg software.

C. Data Augmentation

The next step in the process of AI model development is data augmentation. Data augmentation denotes increasing the input which involves rotation of the existing images randomly, zooming in, flipping the images, etc. Random brightness was given to the images to replicate the field level settings as the intensity of sunlight fluctuates throughout the day inducing changes in the color features. Hence, data augmentation step is considered crucial assuming that the machine will be trained for all the field conditions and is expected to produce reliable prediction in real time situations.

D. Feature Extraction
Features such as color, texture, shape were extracted. Feature extraction is done to retain the patterns of the damage symptoms without loss of information. Four coordinates namely X, Y axis, height and width were considered to identify (or) recognize the datasets.

E. Object Detection
Lastly, CNN architectures such as VGG 16, ResNet were trained based on the extracted features for classification into stem borer infested and healthy leaf. The ResNet model performed better compared to VGG 16 with the training accuracy of 98 % and Validation accuracy of 95 %. Further to achieve cent per cent accuracy, we tried Object detection model YOLO V3. Object detection refers to the identification of each object present in the given image. The YOLO V3 model identified the presence of white ear in the image indicated by the boxes in the image. The percentage of white ear present in each box is reflected in the predicted output image. If we take mean of the percentage of white ear in each box, we can arrive the percentage of white ear damage symptom present in the picture comprising of healthy grains, leaves etc.

3 RESULTS AND DISCUSSIONS

Data collection and labeling is a tedious work. More training samples (large datasets) are needed in order to predict the disease more accurately and improve the generalization. One particular CNN model will not be the best for prediction of different symptoms expressed in different plant parts. Speed of detection needs to be faster which requires high computational/ IT infrastructure resources like GPU, Tensorflow.

The framework architecture of *M-Velanmai* extension advisory system comprised of three major components. They are, 1. End users 2. Features and 3. Database.

1. End users:
The End users are farmers, extension workers and agricultural professionals who might seek extension advisories through the *M-Velanmai* application, presently designed for paddy crop.
User friendly interface has been created for the access by users through two platforms namely an android mobile application and web application so that the project administrators and agricultural experts (TNAU Scientists) can use both the mobile and personal computer devices to access *M-Velanmai* system. However, farmers (users) access is restricted to mobile application only. The users are allowed to access the *M-Velanmai* system through registration process authenticated by the application administrators (TNAU).

2. Features:
The computational features of the *M-Velanmai* system consists of eight units namely,
1. Personal Settings
2. Personal Analytics
3. Analytics dashboard
4. Recommendation Engine Editor
5. Report template editor
6. Deep learning Engine
7. Rule based AI
8. Report Generation

Once the user hits the *M-Velanmai* system, the 1. Personal Settings, 2. Personal Analytics and 3. Analytics dashboard gets activated to acquire and process the input data provided by the users.

If the system receives image of query as an input data, the Deep Learning engine gets activated to identify the pest image and recognise it using Rule based AI approach. In case, the AI model is able to predict the input (image) to an extent of >95 percent, then the appropriate advisory for tackling the pest problem/query raised by the farmer in the form of an input will be generated by the system (Report generation).

3. Database:
The backend Database of *M-Velanmai* consists of Images, Machine Learning models, Algo Hyper Parameters, Farmer's data and Knowledge bank. These are stored in the cloud server to access recognise and deliver the appropriate solutions based on target query received from the users of the android application.
The database component of *M-Velanmai* architecture consists of five units namely Images, Machine Learning models, Algo Hyper Parameters, Farmer's data and knowledge bank. The farmer/ user's data and input data (image/text) regarding the images of the symptoms collected from field (approximately 5000 per symptom) and the advisories about the package of practices, management of pest/ diseases/ nutritional disorders etc., of a paddy crop form a part of the knowledge bank. The suitable algorithms and AI models/ CNN models fit to predict the pest image provided as input are also stored under Machine Learning models other weather-based parameters, environmental parameters to be considered at the time of pest incidence in farmers' field are stored under

Algo hyper parameters unit which would also be considered to deliver extension advisories to the users of *M-Velanmai* system.

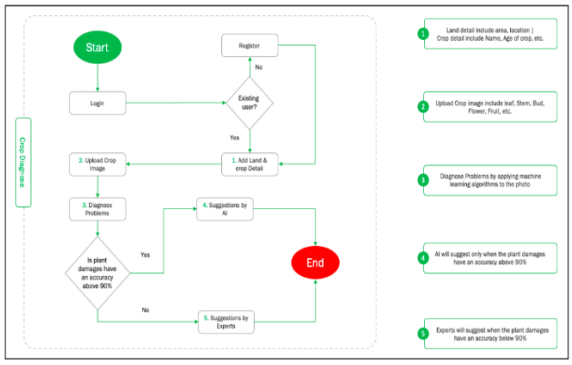

Figure 1: Technology transfer process automated in M-Velanmai application

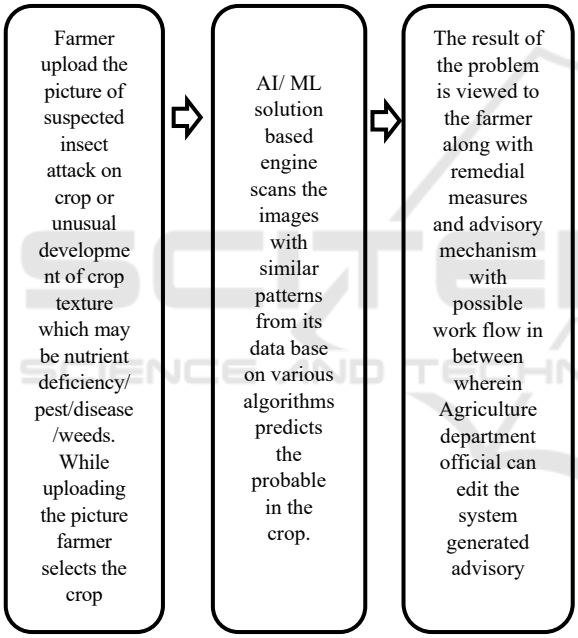

Figure 2: The work flow of the technology outreach process involved in M-Velanmai – Extension model

Features of M-Velanmai app.

The *M-Velanmai* application is designed for use by both farmers and agricultural experts in interactive mode. The special features incorporated in the android application are as follows (Karthikeyan, 2021).

- Bilingual Mode of operation
- Query registration in the various forms such as images, voice, text, etc.
- Instant crop protection advisory to farmers based on Artificial Intelligence
- AI inference validation and Query redressal by TNAU scientists
- Conversational platform supported by text and voice input between farmers & TNAU scientists,
- Continuous flow of push notifications on daily/ weekly basis for crop monitoring,
- Guidance on crop cultivation practices
- Send risk alerts to farmers in case of pest outbreak.

Benefits of M-Velanmai system:

- It is expected that *M-Velanmai* android application developed using Artificial Intelligence technology will deliver appropriate technical advisories in paddy crop to the needed farmers instantly without interference of human elements.
- Farmers can get personalized solutions for their pest related problems instantly in the form of text / voice message in English and/ or Tamil language.
- *M-Velanmai* ensures two-way communication between farmers and agricultural experts and within farmers through creation of an interactive platform to share / exchange information among the users.
- *M-Velanmai* will serve as technology transfer mechanism to address farmers' problems as it saves time and cost of farmers in reaching the experts.
- *M-Velanmai* will cater to the dynamic technological, market and weather-based information needs of farmers.

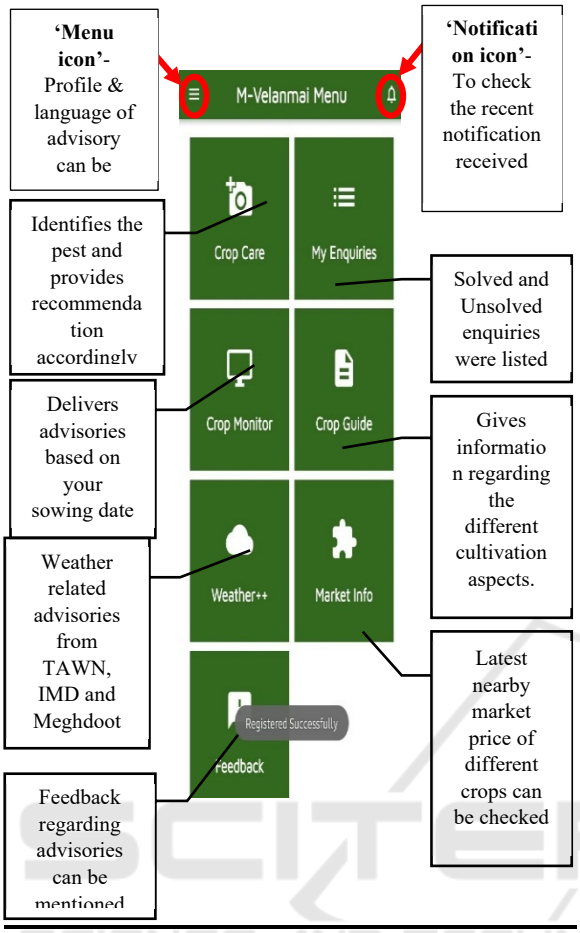

Figure 3: M-Velanmai Menu Page.

4 CONCLUSION

Decision making in the future will be a complex mix of human and computer factors as farmers are seeking ways to improve profitability and efficiency. AI based pest detection smartphone applications can support farmers in monitoring the crop's health by identifying the pests in the field at an early stage. More pragmatic farming can take place with the support of AI which helps in improving agricultural yield and reduce potential environmental risk. However, it is crucial to test and validate the emerging AI applications in agriculture sector as it is impacted by uncontrolled environmental factors unlike other sectors where risk is easier to model and predict. Hence, this AI powered *M-Velanmai* application would serve as a technology provider to the farmers besides an eye opener for agricultural scientists to contribute towards more systematic research on AI in agriculture.

5 CONFLICT OF INTEREST

There is no conflict of interest.

ACKNOWLEDGEMENT

The authors acknowledge the support rendered by World Bank Aided TNIAM Project to fund the study. Technical guidance provided by FarmWise AI consultants are acknowledged.

REFERENCES

Frankenfield, J. (2021). Artificial Intelligence (AI). Retrieved from https://www.investopedia.com/terms/a/artificial-intelligence-ai.asp

Karthikeyan, C. 2020. *M-Velanmai* – Artificial Intelligence Based Agricultural Extension System. In the Souvenir and Extended Abstracts of the International Conference on Recent Trends in Agriculture Towards Food Security and Rural Livelihood: 17-19p.

Karthikeyan, C. 2021. Innovative Approach for Automated Extension Advisory Services. In the Book of Abstracts of the International Conference on Changing Perspectives in Agricultural and Horticultural Research for Sustainable Development, AIASA & Annamalai University: 4-5pp.